REMARKS

Claims 1-28 are all the claims pending in the present application.

The specification and claims 1 and 15 have been amended to clarify that the method and computer program product according to the invention is directed to providing a fast and accurate simulation of a lithographic process and an image formed thereof, with the objective and result of improving the lithographic process. Note that these objectives and amendments are consistent with the discussion in the background of the use of simulation in the industry for improving a lithographic process, for example, as discussed on page 2, line 10 through line 14 on page 6, and more particularly at lines 18-19. Additionally, the background discusses the need in the industry for improvements in both speed and accuracy in simulation (see pages 2-9, and, in particular, page 8, lines 2-5). Thus, no new matter has been added.

Claims 9 and 23 have been amended to clarify the step of determining image intensity in accordance with a Hopkins model using said TCC. The terminology TCC and TCC integral are used interchangeably throughout the specification, for example, at page 17, line 14, referring to the TCC integral of Equation (5), and page 19, line 2, referring to the TCC of Eq. (5). No new matter has been added.

Claims 9, 10, 23 and 24 stand rejected under 35 U.S.C. §112, second paragraph.

Claims 1-28 stand rejected under 35 U.S.C. §101.

Claims 1, 2, 3, 8, 9, 11, 12, 13, 14, 15, 16, 17, 21, 22, 25, 26, 27 and 28 stand rejected on prior art grounds.

A telephone interview was held on January 4, 2007 with Examiner Kimberly Thornewell, Supervisory Examiner Kamini Shah, Applicant/inventor Ron Gordon, and Attorney for Applicant Todd Li. The rejections under 35 U.S.C. §112, second paragraph, and 35 U.S.C. §101, and approaches to overcoming those rejections were discussed. With respect to the prior art rejections, Applicants pointed out that a key aspect of the present invention is that the TCC is determined using contour integrals as opposed to area integrals. Applicants also noted a misprint in the publication of the present application, US Patent Application Publication no. 2005/0015233, as discussed further below.

Reconsideration of the rejections is respectfully requested based on the following discussion.

I. The rejection under 35 U.S.C. §112, second paragraph.

Claims 9, 10, 23 and 24 stand rejected under 35 U.S.C. §112, second paragraph, as being indefinite, because claims 9 and 23 recite the limitation "said TCC integral" in line 2, for which there is insufficient antecedent basis for this limitation. Accordingly, claims 9 and 23 have been amended to clarify the step of determining image intensity in accordance with a Hopkins model using said TCC. Applicants note that the terminology TCC and TCC integral are used interchangeably throughout the specification, for example, at page 17, line 14, referring to the TCC integral of Equation (5), and page 19, line 2, referring to the TCC of Eq. (5). No new matter has been added.

Applicants respectfully request that these rejections be reconsidered and withdrawn.

II. The rejection under 35 U.S.C. §101.

Claims 1-28 stand rejected under 35 U.S.C. §101 because the claimed invention is allegedly directed to non-statutory subject matter. The Office Action alleges that Applicant has not set forth a tangible invention and that claims 1 and 15 claim ideas that are abstract in nature, and lack either a tangible result or a physical transformation.

Applicants have amended claims 1 and 15 to recite a method for improving a lithographic process, and to positively recite the method steps of simulating an image of said mask in accordance with said lithographic process using said TCC; and using said image to improve said lithographic process. Support is provided, for example, at page 2, lines 10-21, which discusses that techniques for improving the lithographic process, such as resolution enhancement techniques (RETs), require simulation, and that such simulation is a major ingredient in the design stage (of RET). No new matter has been added. Applicants submit that claims 1 and 15, as amended, claim a physical transformation (i.e. using said image to improve said lithographic process).

Applicants respectfully request that these rejections be reconsidered and withdrawn.

III. The 35 U.S.C. §102(e) Rejection based on Socha.

Claims 1, 2, 8, 9, 11, 12, 15, 16, 21, 22, 25 and 26 stand rejected under 35 U.S.C. §102(e) as being anticipated by Socha (US Patent Application Publication no. 2002/0152452).

The present invention is directed to a method and a computer program for performing the method steps of, inter alia, defining an integration region spanning the intersection of said source function with said first and second paraxial pupil functions, said integration region having a boundary comprising a finite number of arcs; integrating said integrand for each of said finite number of arcs to obtain a finite number of contour integrals each corresponding to one of said finite number of arcs, wherein each of said finite number of contour integrals comprises an analytical solution; determining a transmission cross-coefficient (TCC) comprising a sum of said finite number of contour integrals. Applicants note that a key aspect of the present invention is that the TCC is determined using contour integrals as opposed to area integrals.

As understood, Socha discloses a method of optimizing an illumination profile for a selected patterning structure pattern, comprising defining a transmission cross coefficient function (page 2, paragraphs [0019]-[0020]). Socha discloses the TCC for a 4-D discrete point (m,n,p,q) is the integral of the shaded area where all three circles (in FIG. 1) overlap (see Eqn. 1 and FIG. 1). Socha discloses an unaberrated TCC, TCCo(m,n,p,q) in Equation 27 and aberrated TCC, TCC(m,n,p,q) in Equation 28. However, Socha fails to disclose integrating said integrand for each of the finite number of arcs (that comprise the boundary of the integration region) to obtain a finite number of contour integrals each corresponding to one of said finite number of arcs, wherein each of said finite number of contour integrals comprises an analytical solution.

Note that in each of Equations 1, 27 and 28 of Socha, the integrals are area integrals. By contrast, in accordance with the present application, the area integrals are converted to contour integrals, and the contour integrals, rather than the area integrals, are used to determine the TCCs (see page 29, Equations 36 and 37, and the discussion from page 29, line 11 through page 30, line 21). Thus, Socha fails to teach each and every aspect of the present invention.

Therefore, Applicants submit that Claims 1, 2, 8, 9, 11, 12, 15, 16, 21, 22, 25 and 26 are patentable over Socha. Thus, Applicants respectfully request that these rejections be reconsidered and withdrawn.

IV. The 35 U.S.C. §103(a) Rejection based on Socha in view of Kintner.

Claims 3 and 17 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Socha as applied to claims 1, 2, 8, 9, 11, 12, 15, 16, 21, 22, 25 and 26, in view of Kintner, "Method for the Calculation of Partially Coherent Imagery," published in Applied Optics Vol. 17, No. 17, September 1978.

As discussed above, Socha fails to teach each and every aspect of Applicant's invention. In particular, Socha fails to disclose integrating said integrand for each of the finite number of arcs (that comprise the boundary of the integration region) to obtain a finite number of contour integrals each corresponding to one of said finite number of arcs, wherein each of said finite number of contour integrals comprises an analytical solution.

As understood, Kintner discloses the properties of a given optical system are described in terms of the transmission cross coefficient, and for aberration-free systems with circular pupils, the cross coefficient can be calculated analytically, and for aberrated or apodized sysems, a 1-D approximation can be used (Abstract). However, Kintner fails to overcome the deficiencies of Socha, and in particular, Kintner fails to teach or suggest integrating said integrand for each of the finite number of arcs (that comprise the boundary of the integration region) to obtain a finite number of contour integrals each corresponding to one of said finite number of arcs, wherein each of said finite number of contour integrals comprises an analytical solution. Therefore, one skilled in the art would not be motivated to combine the teachings or suggestions of Socha and Kintner to arrive at the present invention.

Thus, Applicants submit that claims 3 and 9 are patentable over the cited references, and respectfully request that these rejections be reconsidered and withdrawn.

V. The 35 U.S.C. §103(a) Rejection based on Socha in view of Arnison et al.

Claims 13, 14, 27 and 28 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Socha as applied to claims 1, 2, 8, 9, 11, 12, 15, 16, 21, 22, 25 and 26, in view of Arnison et al., "A 3D Vectorial Optical Transfer Function Suitable for Arbitrary Pupil Functions," published by Elsevier Science, September 2002.

As discussed above, Socha fails to teach each and every aspect of Applicant's invention. In particular, Socha fails to disclose integrating said integrand for each of the finite number of arcs (that comprise the boundary of the integration region) to obtain a finite number of contour integrals each corresponding to one of said finite number of arcs, wherein each of said finite number of contour integrals comprises an analytical solution.

As understood, Arnison et al. disclose calculating a 3D vectorial optical transfer function directly from the vectorial pupil function, without making the paraxial assumption nor assuming radically symmetric pupils (Abstract). However, Arnison et al. fails to overcome the deficiencies of Socha, and in particular, Arnison et al. fails to teach or suggest integrating said integrand for each of the finite number of arcs (that comprise the boundary of the integration region) to obtain a finite number of contour integrals each corresponding to one of said finite number of arcs, wherein each of said finite number of contour integrals comprises an analytical solution. Therefore, one skilled in the art would not be motivated to combine the teachings or suggestions of Socha and Arnison et al. to arrive at the present invention.

Thus, Applicants submit that claims 13, 14, 27 and 28 are patentable over the cited references, and respectfully request that these rejections be reconsidered and withdrawn.

VI. Misprint in U.S. Patent Application Publication No. 2005/0015233

Applicants note that the US Patent Application Publication No. 2005/0015233 of the present application contains a misprint in Equation (41) and in the first line of paragraph [0119], as compared to the application as filed by Applicants. Publication No. 2005/0015233 contains the expression for Equation (41): $\nabla \hat{} F = \exp(-i\,2\pi\, a \cdot \sigma)\hat{z}$, whereas the correct expression for Equation (41) in the application as filed is:

$\nabla \wedge \mathrm{F} = \exp(-i\,2\pi\,\mathrm{a}\cdot\sigma)\hat{z}$. Similarly, the first line of paragraph [0119], or equivalently, the first line after Equation (42), contains the expression: $\nabla\hat{}\,\mathrm{F}$, whereas the correct expression in the first line after Equation (42) in the application as filed is: $\nabla \wedge \mathbf{F}$. In particular, the symbol " $\wedge$ " should not be reproduced as a superscript character.

Applicants note that the expression $\nabla \wedge \mathbf{F}$ in Equation (42) is correctly reproduced in Publication No. 2005/0015233.

CONCLUSION

In view of the foregoing, Applicants submit that claims 1-28, all the claims currently being examined in the application, are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time. Should the Examiner find the application to be other than in condition for allowance, the Examiner is invited to contact the undersigned at the telephone number listed below to discuss any other changes deemed necessary. The Commissioner is authorized to charge any additional fees due or credit overpayments to Deposit Account No. 09-0458.

Applicants' undersigned attorney may be reached by telephone at (845) 894-6919. All correspondence should continue to be directed to the address listed below.

Respectfully submitted,

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